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EP 0451623 A1 EP 0259129 A2 WO 95/13668 A1  
US 4862182 A

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(54) Antenna switching means for portable radio apparatus

(57) Portable radio apparatus such as a portable telephone handset comprises a main antenna 5 which has an operating position extending from the body of the handset and a stowed position, and an auxiliary antenna 9 for use when the main antenna is in the stowed position. The apparatus has mechanical or electronic switching means 39, 43 to allow the apparatus to use solely the main antenna when the main antenna is in the operating position and to allow the apparatus to use solely the auxiliary antenna when the main antenna is in a stowed position. Circuitry may be provided in order to impedance match both antennae to the apparatus (61, 63 figure 8).

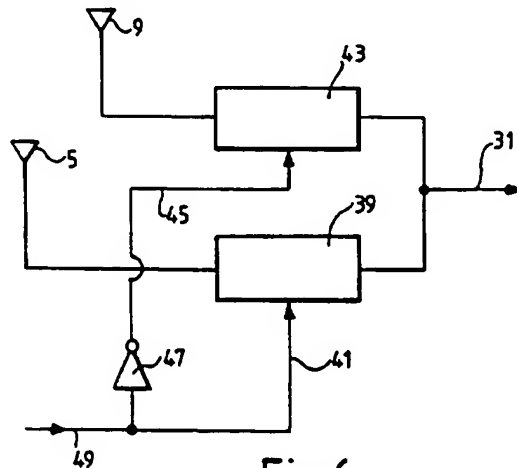


Fig.6.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

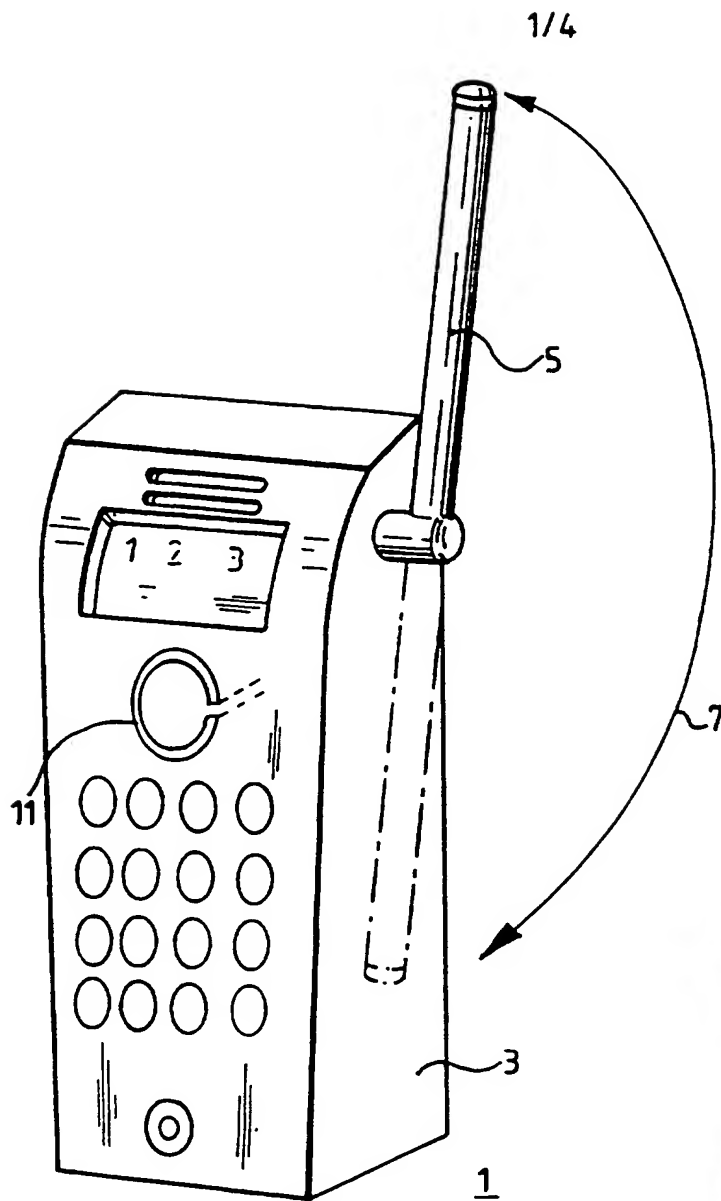


Fig.1.

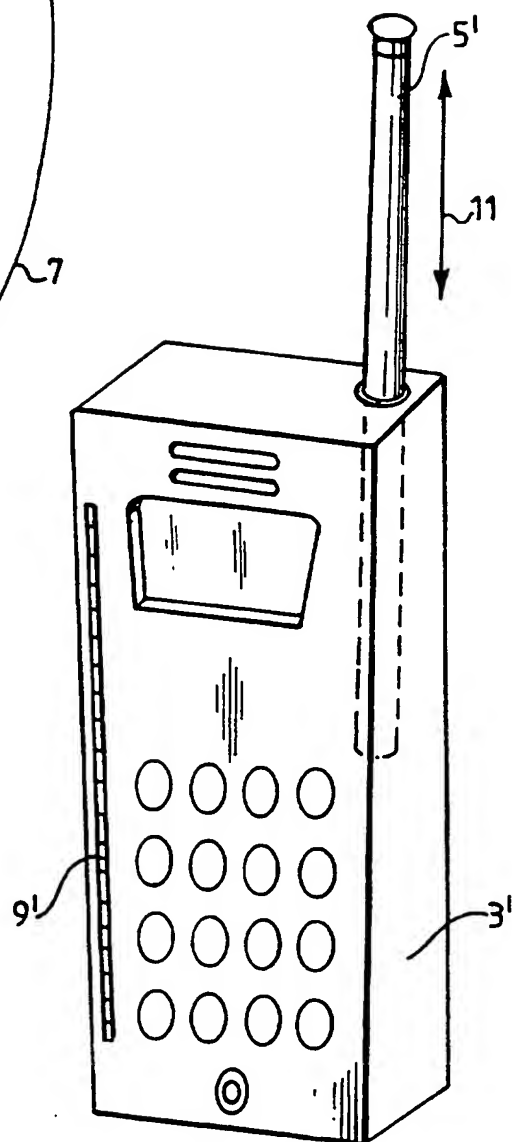


Fig.2.

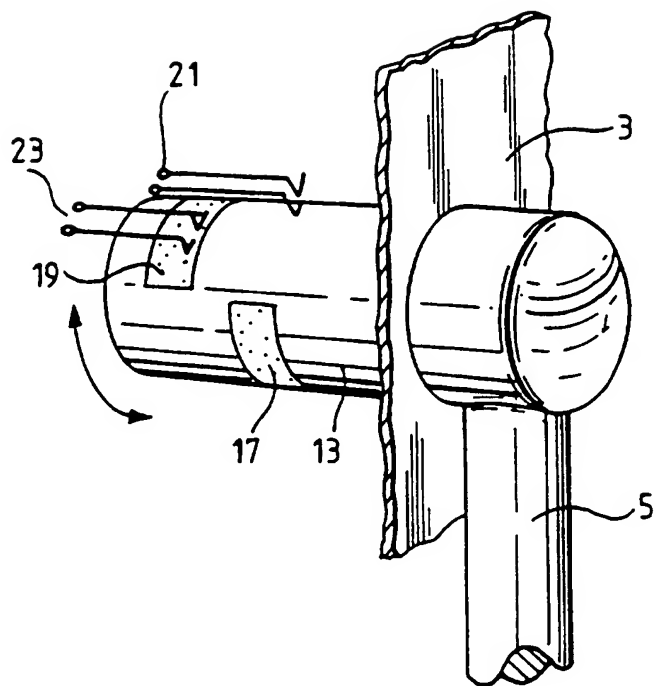


Fig.3.

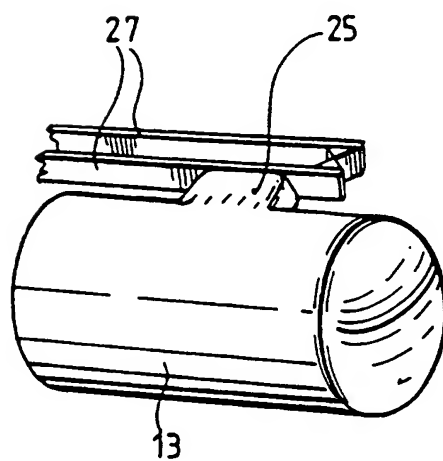


Fig.4.

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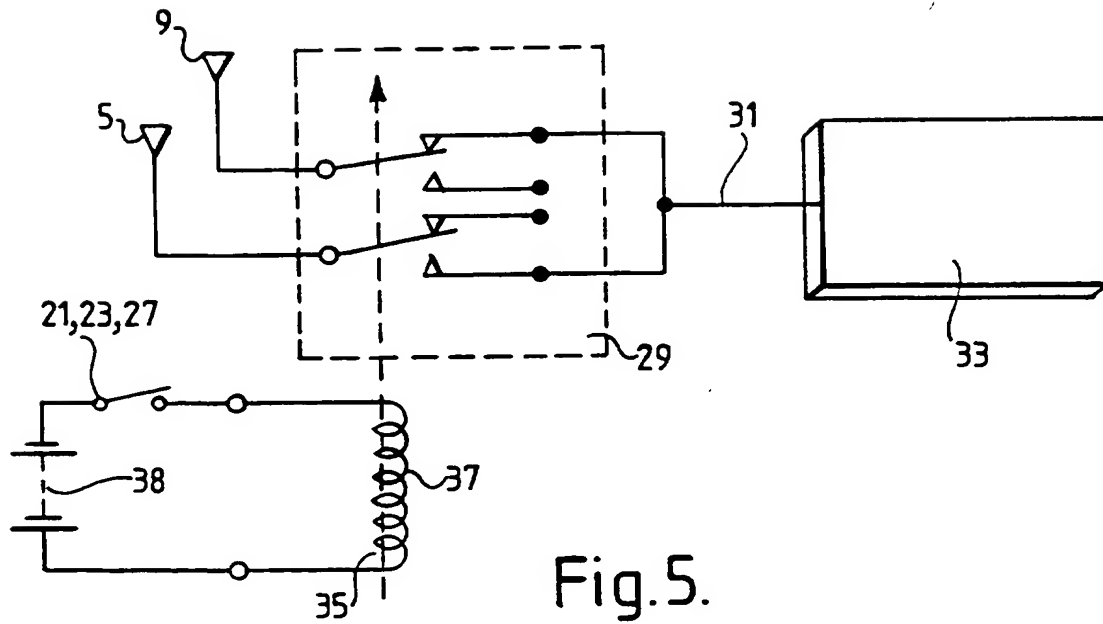


Fig. 5.

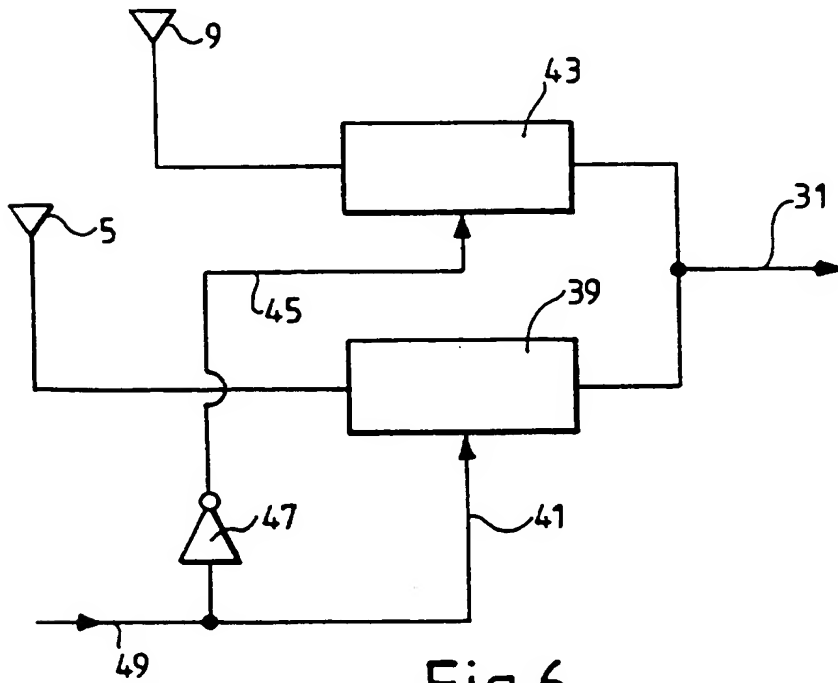


Fig. 6.

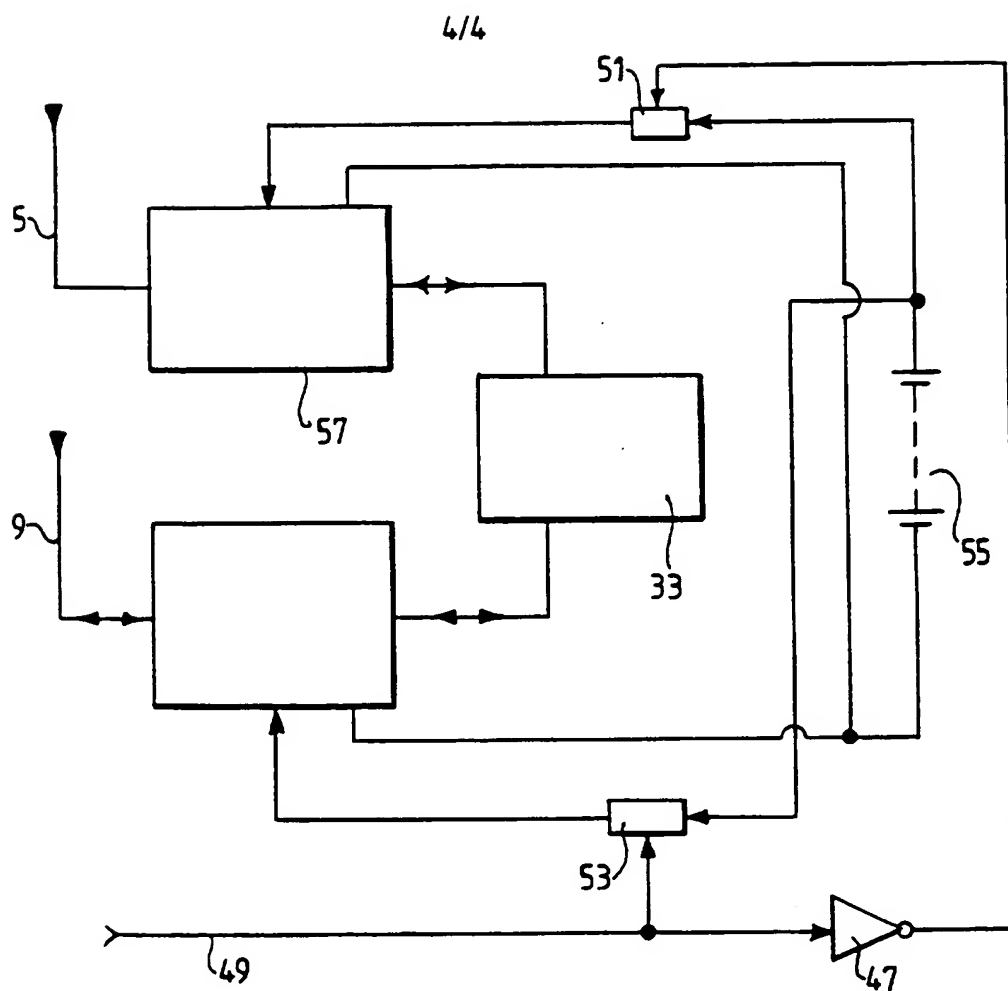


Fig.7.

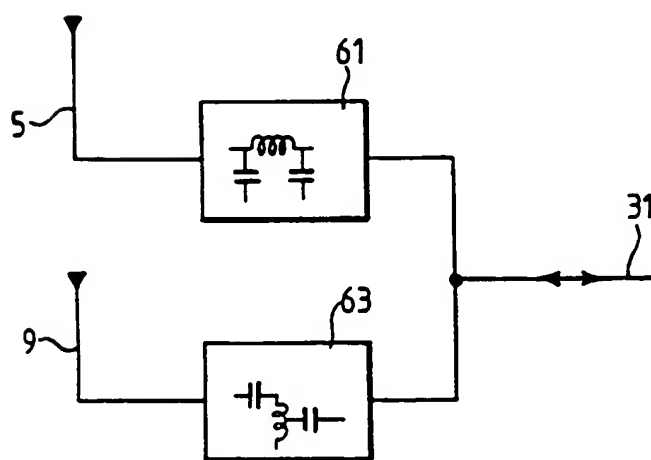


Fig.8.

**2317993**

PORTABLE RADIO APPARATUS

The present invention relates to portable radio apparatus. More particularly, it relates to portable radio transmitters and receivers where transmission and reception are achieved using a common antenna. Most particularly, it relates to those transmitters and receivers where the antenna is extendible for use and withdrawable when not in use. Examples of such radio transmitters and receivers are to be found in mobile telephone handsets and walky-talkies.

For the purpose of clarity, an antenna is hereinafter defined as being coupled to an apparatus for receiving and transmitting radio signals when radio frequency energy can be delivered from the antenna to the apparatus and/or the apparatus can deliver radio-frequency energy to the antenna.

Portable radio transmitters and receivers (colloquially known as transceivers) are now common. The greatest proliferation has been found in the explosive growth in the market for portable telephone handsets. These transceivers are required to be small, light, and to fit into a pocket or a drawer. The portable telephone handset is generally provided with an antenna, used both

for transmission and reception. The antenna can be extended for use and retracted or withdrawn when not in use. The antenna is efficient when in the extended position but extremely inefficient in the retracted position.

Some transceivers are not totally dormant when not in use. For example, telephone handsets which operate directly with a satellite are periodically interrogated by the satellite to determine their location and accessibility. The satellite sends out a short burst message directed to the particular handset and, when the handset detects the incoming short burst message, it responds by transmitting its own message to the satellite. The system, which includes the satellite, then knows the approximate location and active status of the handset and can quickly acknowledge conceivability and quickly make a connection for any call, from another source, directed to that handset. Such activity need not be confined to satellite systems. Terrestrial systems could act in a similar way.

Similarly, walky-talkies as used by police and security personnel, can periodically be accessed to determine the safety of the user.

A great problem arises when the antenna is retracted. The efficiency is extremely small. The antenna, by being moved, relative to parts of itself and/or the body components of the handset, becomes detuned from the operating frequency or frequencies it employs. The handset has great difficulty in receiving the incoming interrogation message. Even if the interrogation message is received, the responding transmission, from the handset, may be so weak that it is never heard. A dilemma is thus created. The antenna must be extendible to be clear of the user's head so that signal masking, by the user, is minimised. Equally, the antenna must be retractable for convenient storage when not in use. Unfortunately, the retracted antenna severely compromises the ability of the transceiver to hear and respond to system interrogation messages. The present invention seeks to provide a solution to that dilemma.

The present invention consists in a portable apparatus for receiving and transmitting radio signals, said apparatus comprising: a body; a main antenna, extendible away from said body to occupy an operating position and withdrawable towards said body to occupy a stowed position; an auxiliary antenna, proximate to or within said body; and switching means, coupled to respond



to the position of said main antenna to couple said auxiliary antenna to said apparatus when said main antenna is in said stowed position and to decouple said auxiliary antenna from said apparatus when said main antenna is in said operating position.

The invention also provides that the switching means may be further operative to decouple the main antenna from the apparatus when the main antenna is in the stowed position.

The invention further provides that the switching means can comprise a mechanical antenna switch, mechanically coupled to respond to the position of the main antenna, and acting directly upon at least one electrical connection to the auxiliary antenna.

The invention, yet further, provides that the mechanical antenna switch can be further operative to act directly upon at least one electrical connection to the main antenna.

Still further, the invention provides that the switching means can comprise a sensor for detecting the position of the main antenna and coupled to operate a slave switch acting directly upon at least one electrical connection to said auxiliary antenna.

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Even further, the invention provides that the slave switch can be further operative to act directly upon at least one electrical connection to the main antenna.

The invention, as embodied, has, for preference, the slave switch comprising a relay and/or an electronic gate.

According to yet another aspect of the present invention, the switching means is provided in the form of a pair of mutually interactive matching networks, a first matching network being operative to match the main antenna to the apparatus, and the second matching network being operative to match the auxiliary antenna to the apparatus, where, when the main antenna is in the operating position, the first antenna is matched to the apparatus and the second antenna is not matched, and where, when the main antenna is in the stowed position, the auxiliary antenna is matched to the apparatus and the main antenna is not matched.

The present invention is further explained, by way of example, by the following description, read in combination with the appended drawings, in which:

Figure 1 shows a portable telephone handset wherein the main antenna can be swung from an operating position to a stowed position.

Figure 2 shows a portable telephone handset wherein the main antenna can be retracted into the body of the handset.

Figure 3 shows a cutaway view of figure 1 illustrating an exemplary manner of achieving the desired switching function.

Figure 4 is an alternative method to that shown in figure 3.

Figure 5 is a schematic representation of a switching scheme according to the present invention.

Figure 6 shows an alternative, electronic embodiment of the general switching scheme, according to the present invention.

Figure 7 shows a further electronic embodiment of the present invention.

and

Figure 8 shows an embodiment employing a pair of mutually interactive antenna impedance matching networks.

Figure 1 shows a first example of a portable telephone handset whereto the present invention can be applied. A portable telephone handset 1 includes a body 3

and a main antenna 5. The main antenna 5 is shown, in solid form, in a raised, operating position, but can be stowed, by rotation indicated by first arrow 7, to a stowed position whereat it is shown in broken line. As well as all of the features familiar on a portable telephone, there is also included an auxiliary antenna 11. The auxiliary antenna 11 is here shown, only by way of example, in the form of a loop.

Figure 2 shows a second example of a portable telephone handset 1' whereto the invention can also be applied. Once again, the main antenna 5' is shown solid in its operating position and in broken line in its stowed position, being moveable there between as indicated by a second arrow 11. The main antenna 5' is withdrawn from and inserted into the body 3' of the handset 1'. The auxiliary antenna 9' is, in this example, shown in the form of a linear conductor.

In certain types of portable telephone only one frequency band is employed. These require only simple antennae 5 5' 9 9'. Other portable telephones, for example, transmit on one band and receive on another, and may have several subdivisions within each band which are used. It is to be emphasised that, although the antennae 5 5' 9 9' in the examples are shown in generic, simple

form, they can be complex devices capable of operation on multiple frequencies and may contain more than one electrical conductor.

The auxiliary antenna 9 9' is not limited in its form by the examples here given. The only requirement thereupon is that the auxiliary antenna 9 9' should be capable of receiving and transmitting radio signals in the absence of function of the main antenna 5 5'. It may take the form of a monofilar or multifilar helical whip, single or multiple loops, one or more linear elements, an inductively or capacitively loaded structure, a slow wave structure, or, indeed, any shape, form or construction that will fulfil the designers desired function.

Likewise, the main antenna 5 5' is not limited in its form by the examples given. Any main antenna 5 5' where there exists an operating position where the main antenna 5 5' is functional and a stowed position where it is not can be incorporated into the present invention.

It is envisaged that the auxiliary antenna 9 9' can take many positions. The two examples shown are conformal with the outside of the body 3 3' of the portable telephone handset 1 1'. Equally well, they could be attached close to the body 3 3', or be contained within the body 3 3'. When contained within the body 3

3', the auxiliary antenna 9 9' can be a discreet component or can be formed by tracks on a printed circuit board otherwise forming another component part of the radio transmission and reception apparatus held within the body 3 3'.

Figure 3 shows one way of embodying the invention, based on the portable telephone handset of figure 1. The main antenna 5 penetrates the wall of the body 3 and rotates a switching shaft 13. As the main antenna 5 is moved from the operating position to the stowed position, so the switching shaft 13 moves as indicated by a third arrow 15. First 17 and second 19 conductive areas are provided on the switching shaft 13 to co-operate with first 21 and second 23 contact sets. The contact sets 21 23 are displaced, relative to each other, in the direction of the axis of the shaft 13 and rest upon the surface of the shaft 13. The conductive areas 17 19 are also displaced, on the outer surface of the shaft 13, in the direction of the axis of the shaft 13 and are also relatively angularly displaced such that when the main antenna 5 is in the operating position the first conductive area 17 completes the electrical circuit between the elements of the first conductor set 21 while the electrical circuit between the elements of the second

conductor set 23 remains open and when the main antenna is in the stowed position the second conductive area 19 completes the electrical circuit between the elements of the second contact set 23 while the electrical circuit between the elements of the first conductor set 21 remains open. The first contact set 17, as will become apparent, brings the main antenna 5 into use while the second contact set 23 disconnects the auxiliary antenna 9. The second contact set 23 brings the auxiliary antenna 9 into use while the first contact set disconnects the main antenna 5.

Figure 4 shows another way that the shaft 13 can be used to create an electrical switching action. One of several cams 25 are disposed around and along the shaft 13 each to operate a respective one of a corresponding severality of spring contact sets 27, disposed along and around the shaft 13 for each to interact with its respective cam 25 and each connected variously either to the main antenna 5 or the auxiliary antenna 9 to achieve the switching action hereinbefore and hereinafter described.

While the examples given in figures 5 and 6 are of a simple nature with only a small number of contact sets 21 23 27 shown, where it is desired directly to act

upon some or all of the electrical connection to the antennae 5 9 by means of a straightforward mechanical switching action, and where each of the antennae may comprise a plurality of conductors, it is to be appreciated that the number of contact sets 21 23 27 would be increased to meet the direct switching requirement.

Figure 5 is a schematic representation of the switching scheme according to the present invention.

A generic switch 29 selectably connects either the main antenna 5 or the ancillary antenna 9 to the input/output 31 of the transceiver 33 portion of the portable telephone handset 1. Thus, one or the other of the antennae 5 9 is selected. Figures 3 and 4 show how at least part of the generic switch 29 can be implemented using electrical contact sets directly to switch through one, the other or both of the antennae 5 9 to the transceiver 33. There now follows a description of a further manner in which the switching function can be achieved.

In the further manner, switching is achieved not directly, or entirely directly, by the mechanical movement of the main antenna 5, but rather, at least in part, by sensing the position of the main antenna 5 and



using the signal, derived from the sensing operation, to drive a conveniently located slave switch.

Examining again figures 3 and 4, those skilled in the art will be aware that the switch contact sets 21 23 27 can, individually, be used to sense the position of the main antenna 5 rather than be used directly to effect electrical switching of the signals to and from the antennae 5 9. Turning now to figure 5, and embodying the generic switch 29, this time, as the contact array of a selectably operable relay 35, any one of the contact sets 21 23 27 of figures 3 and 4 can, in the simplest of examples, be used to energise the coil 37 from a power source 38 to operate the contact array 29 to achieve the desired switching function.

The switching need not be achieved by mechanical means, It is known to employ PIN and ordinary diode networks to switch high frequency signals. Equally, other means exist employing field effect transistors which may be switched from a non-conductive to a conductive state using low current control signals. All of these devices are examples of electronic switches. Those, skilled in the art will be aware of many further devices which may equally be employed.

Figure 6 shows an implementation of the present

invention employing electronic switches. A first electronic switch 39 is controlled by a first logic input selectably either to provide a conductive path for the main antenna 5 or not to provide a conductive path. A second electronic switch 43 is controlled by a signal on a second logic input 45 selectably either to provide or not to provide a conductive path for signals to and from the auxiliary antenna 9. A control line 49 provides a logic signal to the first logic input 41 and a logical inverter 47 inverts the logical sense of the control signal 49 for application to the second logic input 45. Thus, the control signal 49 ensures that always one or the other, but never both, of the electronic switches 39 43 provides its conductive path.

Figure 7 shows a further embodiment. The control line 49 and inverter 47 are used to control a first power electronic switch 51 and second power electronic switch 53 selectably to switch electrical power from a power source 55 to a first front end module 57 servicing the main antenna 5 and a second front end module 59 servicing the auxiliary antenna 9. Each front end module 57 59 is specifically provided with an input amplifier and an output power amplifier, together with a matching network, each appropriate to their respective antenna 5 9. Either

the first front end module 57 or the second front end module 59 is energised, but never both together, to interact with the transceiver 33 and thus couple their respective antenna 5 9 thereto. The power electronic switches 51 53 can, by way of non restrictive example, be series pass transistors, FET switches, selectably activateable regulators and the like.

Figure 8 shows yet another embodiment of the invention. The main antenna 5 is coupled to the input 31 of the transceiver 33 via a first matching network 61. The ancillary antenna 9 is coupled to the input 31 of the transceiver 33 via a second matching network 63. The precise design of the matching networks 61 63 is at the option of the designer.

The present embodiment seeks just one constraint on the networks 61 63. When the main antenna 5 is in the operating position the first matching network 61, in compatibility with the presence of the second matching network 63 in common on the input 31 of the transceiver 33, provides a good impedance match between the main antenna 5 and the input 31 of the transceiver 33 whereas, under these conditions, the reactance, seen by the second matching network 63 at the input 31 to the transceiver is incorrect for matching the ancillary antenna 9 to the

input 31 of the transceiver 33. Under these conditions, the main antenna 5 predominates and the degree of coupling of the ancillary antenna 9 is very small.

When the main antenna 5 is in the stowed position, the change in characteristics of the main antenna 5 result in a very poor match being achieved by the first matching network 61 between the main antenna 5 and the input 31 of the transceiver 33. The reactance, presented by the first matching network 61 to the input 31 of the transceiver 33 has changed, and is just the correct value to alter the characteristics of the second matching network 63 such that a good match is achieved between the ancillary antenna 9 and the input 31 of the transceiver 33. Under these conditions, the coupling to the main antenna is very small and the ancillary antenna 9 predominates.

In this manner, the movement of the main antenna 5 itself and the consequent changes in its electrical characteristics are detected by the resultant alteration in the matching characteristics of a pair of mutually interactive matching networks so that, when the main antenna 5 is in the operating position, it is correctly matched to the input 31 of the transceiver 33 and the ancillary antenna is not, whereas when the main antenna 5

is in the stowed position the ancillary antenna 9 is  
correctly matched to the input 31 of the transceiver 33  
whereas the main antenna 9 is not.

## CLAIMS

1. A portable apparatus for receiving and transmitting radio signals, said apparatus comprising: a body; a main antenna, extendible away from said body to occupy an operating position and withdrawable towards said body to occupy a stowed position; an auxiliary antenna, proximate to or within said body; and switching means, coupled to respond to the position of said main antenna to couple said auxiliary antenna to said apparatus when said main antenna is in said stowed position and to decouple said auxiliary antenna from said apparatus when said main antenna is in said operating position.

2. An apparatus according to claim 1 wherein said switching means is further operative to decouple said main antenna from said apparatus when said main antenna is in said stowed position.

3. An apparatus according to claim 1 or claim 2 wherein said switching means comprises a mechanical antenna switch mechanically coupled to respond to the position of said main antenna and acting directly upon at least one electrical connection to said auxiliary antenna.

4. An apparatus according to claim 3 wherein said mechanical antenna switch is further operative to act directly upon at least one electrical connection to said main antenna.

5. An apparatus according to claim 1 or claim 2 wherein said switching means comprises a sensor for detecting the position of said main antenna and coupled to operate a slave switch acting directly upon at least one electrical connection to said auxiliary antenna.

6. An apparatus according to claim 5 wherein said slave switch is further operative to act directly upon at least one electrical connection to said main antenna.

7. An apparatus according to claim 5 or 6 wherein said slave switch comprises a relay.

8. An apparatus according to claim 5, 6 or 7 wherein said slave switch comprises an electronic gate.

9. An apparatus according to claim 2 wherein said switching means comprises: a first matching network for matching said main antenna to said apparatus; and a second matching network for matching said auxiliary antenna to said apparatus; wherein said first and second matching networks are mutually interactive for said main antenna to be matched to said apparatus and said auxiliary antenna not to be matched to said apparatus

when said main antenna is in said operating position; and for said auxiliary antenna to be matched to said apparatus and said main antenna not to be matched to said apparatus when said main antenna is in said stowed position.

10. An apparatus substantially as described with reference to the appended drawings.





Application No: GB 9620578.6  
Claims searched: 1 to 10

Examiner: Glyn Hughes  
Date of search: 30 January 1997

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:  
UK CI (Ed.O): H1Q (QAX, QKC, QKE, QKX), H4L (LECX)  
Int CI (Ed.6): H01Q (1/08, 1/10, 1/22, 1/24), H04B (1/38)  
Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X, Y	EP 0451623 A1 (NOKIA) see in particular figure 1 and column 2 lines 30 to 52	X: 1 to 4 Y: 5, 6 and 8
X	EP 0259129 A2 (NEC) see in particular figures 3A and 3B and column 4 line 27 to column 5 line 9	1 to 4
Y	WO 95/13668 A1 (MOTOROLA) see in particular page 3 line 22 to page 4 line 8.	Y: 5, 6 and 8
X	US 4862182 (EGASHIRA) see in particular figure 1 and column 3 line 57 to column 4 line 18	1 to 4

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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